photographer and the person photographed? What is the nature of the pose assumed by the person photographed? To what extent is the pose influenced by cultural factors? How does the nature of the photograph a person takes change from childhood to maturity? Who within the family takes photographs and who is photographed most often? What does this tell us about the inner emotional life of the family? To what extent does taking a photograph prevent a person from fully savoring the special qualities of the moment in exchange for a future record of it? When we photograph an event, do we necessarily become an impersonal spectator of it; does this diminish our ability to respond to the event in other ways? These questions chart experimental paths that remain to be explored.

# 19

# The Small World Problem

The problem concerns the manner in which individuals are linked, through bonds of kinship and acquaintance, into complex networks, and the means of devising efficient paths connecting any two points within the network. For the sake of simplicity, let us call this "the small world problem," a phrase long current in our language, but first employed in the social sciences by Ithiel Pool (cited in Rand, 1964).

The simplest way of formulating the small world problem is: "Starting with any two people in the world, what is the probability that they will know one another?" A somewhat more complex formulation, however, takes account of the fact that while persons *X* and *Z* may not know each other directly, they may share a mutual acquaintance—that is, a person who knows both of them. One can then think of an acquaintance chain with *X* knowing *Y* and *Y* knowing *Z*. Moreover, one can imagine circumstances in which *X* is linked to *Z* not by a single link, but by a series of links, that is, *X-a-b-c-d—y-Z*. That is to say, person *X* knows person *a* who in turn knows person *b*, who knows *c*, . . . who knows *y*, who knows *Z*.

Therefore, another question one may ask is: given any two people in the world, person *X* and person *Z*, how many intermediate acquaintance links are needed before *X* and *Z* are connected? There are two general philosophical views on the small world problem. Some people feel that any two people in the world, no

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matter how remote from each other, can be linked in terms of intermediate acquaintances, and that the number of such intermediate links is relatively small.

There is, however, a contrasting view that sees unbridgeable gaps between various groups. Given any two people in the world, they will never link up, because people have circles of acquaintances which will not necessarily intersect. A message will circulate in a particular cluster of acquaintances, but may never be able to make the jump to another cluster. This view sees the world in terms of isolated clusters of acquaintances. The earlier view sees acquaintances in terms of an infinitely intersecting arrangement that permits movement from any social grouping to another through a series of connecting links.

Concern with the small world problem is not new, nor is it limited to social psychologists like myself. Historians, political scientists, and even city planners have spoken of the matter in quite unambiguous terms. Jane Jacobs (1961), who has written on city planning, expressed it in terms that many of us have entertained as children.

> When my sister and I first came to New York from a small city, we used to amuse ourselves with a game we called Messages. The idea was to pick two wildly dissimilar individuals—say a head hunter in the Solomon Islands and a cobbler in Rock Island, Illinois—and assume that one had to get a message to the other by word of mouth; then we would each silently figure out a plausible, or at least possible, chain of persons through which the message could go. The one who could make the shortest plausible chain of messengers won. The head hunter would speak to the head man of his village, who would speak to the trader who came to buy copra, who would speak to the Australian patrol officer when he came through, who would tell the man who was next slated to go to Melbourne on leave, etc. Down at the other end, the cobbler would hear from his priest, who got it from the mayor, who got it from a state senator, who got it from the governor, etc. We soon had these close-to-home messengers down to a routine for almost everybody we could conjure up (pp. 134–135).

The importance of the problem does not lie in these entertaining aspects, but in the fact that it brings under discussion a certain mathematical structure in society, a structure that often plays a part, whether recognized or not, in many discussions of history, sociology, and other disciplines. For example, Henri Pirenne (1925) and George Duby (1958) make the point that in the dark ages communication broke down between cities of western Europe. They became isolated and simply did not have contact with each other. The network of acquaintances of individuals became constricted. The disintegration of society was expressed in the growing isolation of communities, and the infrequent contact with those living outside a person's immediate place of residence.



## THE UNDERLYING STRUCTURE

Sometimes it is useful to visualize the abstract properties of a scientific problem before studying it in detail; that is, we construct a model of the main features of the phenomenon as we understand them. Graph theory, which is concerned with the mathematical treatment of networks, provides a convenient way of representing the structure of acquaintanceships. (Harary, Norman, and Cartwright, 1965)

Let us represent all the people in the United States by a number of points. Each point represents a person, while lines connecting two points show that the two persons are acquainted. Each person has a certain number of firsthand acquaintances, which we shall represent by the letters $a, b, c, \ldots n$. Each acquaintance in turn has his own acquaintances, connected to still other points (see Figs. 19.1 and 19.2).

The exact number of lines radiating from any point depends on the size of a person's circle of acquaintances. The entire structure takes on the form of a complex network of 200,000,000 points, with complicated connections between them. One way of restating the small world problem in these terms is this: given any two of these points chosen at random from this universe, through how many intermediate points would we pass before they could be connected by the shortest possible path?

There are many ways to go about the study of the small world

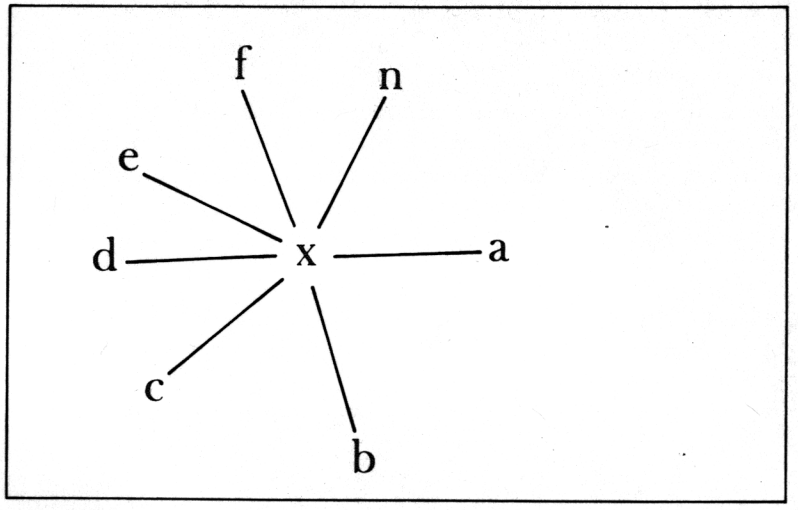
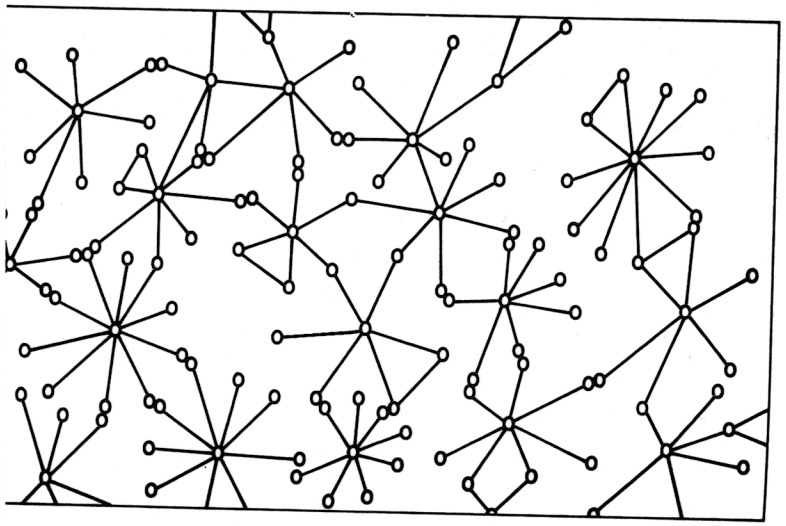



FIGURE 19.1
Acquaintances of X, $a, \ldots, n$.



GURE 19.2
etwork of acquaintances.

problem, and I shall soon present my own approach to it. But first, let us consider the contributions of a group of workers at MIT under the leadership of Ithiel de Sola Pool. Pool, working closely with Manfred Kochen of IBM, decided to build a theoretical model of the small world, and the model parallels closely the idea of points and lines shown in Figs. 19.1 and 19.2. To build such a model certain information needs to be known. First, you have to know how many acquaintances the average man has. Surprisingly, though this is a basic question, no reliable answers could be found in the social science literature. So the information had to be obtained, and Dr. Michael Gurevitch, then a graduate student at MIT, set about this task. Gurevitch (1961) asked a variety of men and women to keep a record of all the persons they came in contact with in the course of 100 days. It turned out that on the average, these people recorded names of roughly 500 persons, so that this figure could be used as the basis of the theoretical model. If every person knows 500 other people, what are the chances that any two people will know each other? Making a set of rather simple assumptions, it turns out that there is only about one chance in 200,000 that any two Americans chosen at random will know each other. However, the odds drop precipitously when you ask the chances of their having a mutual acquaintance. And there is better than a 50–50 chance



that any two people can be linked up with two intermediate acquaintances.

Of course, the investigators were aware of the fact that even if a man has 500 acquaintances, there may be a lot of inbreeding. That is, many of the 500 friends of my friend may be actually among the people I know anyway, so that they do not really contribute to a widening net of acquaintances. Figure 19.3 illustrates the phenomenon of inbreeding by showing how the acquaintances of *X* feed back into his circle of acquaintances and do not bring any new contacts into the structure.

It is a fairly straightforward job to check up on the amount of inbreeding using one or two circles of acquaintances, but it becomes almost impossible when the acquaintance chain stretches far and wide. There are just too many people involved to make a count practical.

So the main obstacle in applying a model of this sort is the problem of social structure. Although poor people always have acquaintances, it probably turns out that they tend to be among other poor people, while the rich speak mostly to the rich. It is exceedingly difficult to assess the impact of social structure on a model of this sort. If you could think of the American population as only 200,000,000 points, each with 500 *random* connections, the model would work. But the contours of social structure make this a perilous assumption, for society is not built on random

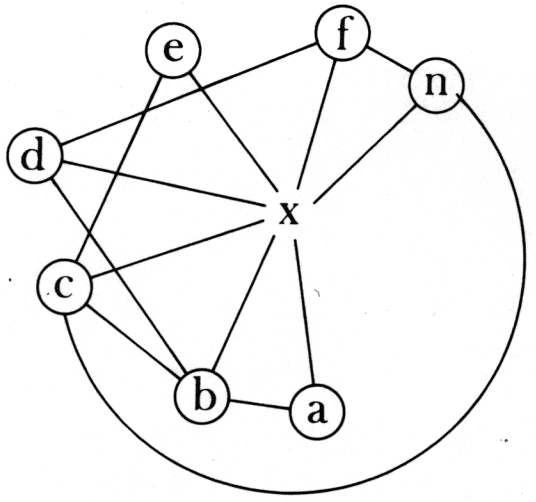



FIGURE 19.3
Inbreeding.

connections among persons, but tends toward fragmentation into social classes and cliques.

But could the problem admit of a more direct experimental solution? The Laboratory of Social Relations at Harvard gave me $680 to prove this was the case. My approach was to try to find an experimental method whereby if two persons were chosen at random, it would be possible to trace a line of acquaintances that linked the two.

Let us assume for the moment that the actual process of establishing the linkages between two persons runs only one way: from person *A* to person Z. Let us call person *A* the *starting* person, since he will initiate the process, and person *B* the *target* person. Then we would ask the starting person to try to establish contact with the target person using only a chain of friends and acquaintances. We could then see how long the chain was, and study many of its other properties. Of course, the starting person cannot, at the outset, know what the complete chain looks like: he cannot see beyond the circle of his immediate acquaintances, and the chance that anyone of his immediate acquaintances would know the target person is small. The starting person cannot see beyond the first link, he can only start the process on its way, by moving it one step toward the target.

The general procedure was to obtain a sample of men and women from varied walks of life. Each of these persons was given the name and address of "Target Person" (that is, an individual chosen at random living somewhere in the United States). Each of the participants was asked to move a message towards the target person using only a chain of friends and acquaintances. Each person could transmit the message to one friend or acquaintance who would be more likely to know the target person than he was. The friend would repeat the process until the message reached the target person. Messages may only move to persons who know each other on a first-name basis.

As a crude beginning, we thought it best to draw our starting people from some distant city such as Wichita, Kansas, or Omaha, Nebraska (from Cambridge, these cities seem vaguely "out there," on the Great Plains or somewhere). So letters of solicitation were sent to residents in these cities asking them to participate in a study of social contact in American society. (For certain purposes, residents of the Boston area were also used.) It was necessary to select a target person and the first individual to serve in this capacity was the wife of a Divinity School student living in Cambridge. In a second study, carried out in collaboration with Jeffrey Travers, the target person was a stock broker who worked in Boston and lived in Sharon, Massachusetts. To keep matters straight, I will refer to the first study as the Kansas study and the second study as the Nebraska study. These terms indicate merely where the starting persons were drawn from. Each person who volunteered to serve as a starting person was sent a document, which is the main tool of the investigation (see Fig. 19.4). I suggest that it be scrutinized to learn the



flavor and details of the procedure, but let us quickly review its main contents. The document contains:

1. The name of the target person as well as certain information about him. This orients the participant toward a specific individual.
2. A set of rules for reaching the target person. Perhaps, the most important rule is stated in box 4; *"if you do not know the target person on a personal basis, do not try to contact him directly. Instead, mail this folder . . . to a personal acquaintance who is more likely than you to know the target person . . . it must be someone you know on a first-name basis."* This rule sets the document into motion, moving it from one participant to the next, until it is sent to someone who knows the target person. Then, rule 3 takes over and the chain is completed.
3. A roster on which the subject affixes his name. This tells the person who receives the letter exactly who sent it to him. The roster also has another practical effect; it prevents endless looping of the document through a participant who has already been an earlier link in the chain. For each participant can see exactly what sequence of persons has led up to his own participation.
4. A stack of fifteen business reply cards.

Several other features of the procedure need to be emphasized. First, the subject operates under the restriction that he can send the folder on only to one other person. Thus, the efficiency with which the chain is completed depends in part on the wisdom of his choice in this matter. Second, by means of the business reply card, we have continuous feedback on the progress of each chain. The cards are coded so we know which chain it comes from and which link in the chain has been completed. The card also provides us with relevant sociological characteristics of the sender and receiver of the card. Thus, we know the characteristics of completed, as well as incompleted, chains. Third, the procedure permits experimental variation at many points.

In short, the device possesses some of the features of a chain letter, though it does not pyramid in any way; moreover it is oriented toward a specific target, zeros in on the target through the cooperation of a sequence of participants, and contains a tracer that allows us to keep track of its progress at all times.

The question that plagued us most in undertaking this study was simply: Would the procedure work? Would any chains started in Kansas actually reach our target person in Massachusetts? The answer came fairly quickly. Within a few days after initiating chains in Kansas, one of the documents was returned to the target person, the wife of a Divinity School student. The document had started with a wheat farmer in Kansas. He

# COMMUNICATIONS PROJECT

322 EMERSON HALL HARVARD UNIVERSITY CAMBRIDGE, MASSACHUSETTS 02138

We need your help in an unusual scientific study carried out at Harvard University. We are studying the nature of social contact in American society. Could you, as an active American, contact another American citizen regardless of his walk of life? If the name of an American citizen were picked out of a hat, could you get to know that person using only your network of friends and acquaintances? Just how open is our "open society"? To answer these questions, which are very important to our research, we ask for your help.

You will notice that this letter has come to you from a friend. He has aided this study by sending this folder on to you. He hopes that you will aid the study by forwarding this folder to someone else. The name of the person who sent you this folder is listed on the Roster at the bottom of this sheet.

In the box to the right you will find the name and address of an American citizen who has agreed to serve as the "target person" in this study. The idea of the study is to transmit this folder to the target person using only a chain of friends and acquaintances.

**TARGET PERSON**

Information about the target person is placed here.

## HOW TO TAKE PART IN THIS STUDY

**1** ADD YOUR NAME TO THE ROSTER AT THE BOTTOM OF THIS SHEET, so that the next person who receives this letter will know who it came from.

**2** DETACH ONE POSTCARD. FILL IT OUT AND RETURN IT TO HARVARD UNIVERSITY. No stamp is needed. The postcard is very important. It allows us to keep track of the progress of the folder as it moves toward the target person.

**3** IF YOU KNOW THE TARGET PERSON ON A PERSONAL BASIS, MAIL THIS FOLDER DIRECTLY TO HIM (HER). Do this only if you have previously met the target person and know each other on a first name basis.

**4** IF YOU DO NOT KNOW THE TARGET PERSON ON A PERSONAL BASIS, DO NOT TRY TO CONTACT HIM DIRECTLY. INSTEAD, MAIL THIS FOLDER (POST CARDS AND ALL) TO A PERSONAL ACQUAINTANCE WHO IS MORE LIKELY THAN YOU TO KNOW THE TARGET PERSON. You may send the folder on to a friend, relative, or acquaintance, but it must be someone you know on a first name basis.

Remember, the aim is to move this folder toward the target person using only a chain of friends and acquaintances. On first thought you may feel you do not know anyone who is acquainted with the target person. This is natural, but at least you can start it moving in the right direction! Who among your acquaintances might conceivably move in the same social circles as the target person? The real challenge is to identify among your friends and acquaintances a person who can advance the folder toward the target person. It may take several steps beyond your friend to get to the target person, but what counts most is to start the folder on its way! The person who receives this folder will then repeat the process until the folder is received by the target person. May we ask you to begin!

Every person who participates in this study and returns the post card to us will receive a certificate of appreciation from the Communications Project. All participants are entitled to a report describing the results of the study.

Please transmit this folder within 24 hours. Your help is greatly appreciated.

Yours sincerely,

Stanley Milgram

Stanley Milgram, Ph. D.
Director, Communications Project

**ROSTER**

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____
8 _____
9 _____
10 _____
11 _____
12 _____
13 _____
14 _____
15 _____

SIGN YOUR NAME HERE.

**PLEASE FILL IN THIS INFORMATION ABOUT YOURSELF**

My Name:

My Address:

My Occupation:

Age: Sex: Race:

Spouse's Occupation:

How many people do you know on a first name basis? Give us your best guess:

Please Fill In The Following Infomation About The Person To Whom You Are Sending The Folder.

His (Her) Name:

His (Her) Address:

His Occupation:

Age: Sex: Race:

Nature of His Relationship to you. (Please explain whether he is a friend, acquaintance, relative, etc.)

Why did you select him to receive the passbook?

DETACH ONE POSTCARD.
FILL IT OUT AND RETURN IT TO HARVARD UNIVERSITY.

FIGURE 19.4
Document used in the small world problem.

passed it on to an Episcopal minister in his home town, who sent it to a minister who taught in Cambridge, who gave it to the target person. Altogether the number of intermediate links between starting person and target person amounted to *two!*

As it turned out this was one of the shortest chains we were ever to receive, for as more tracers and documents came in, we learned that chains varied from 3–10 intermediate acquaintances, with the median at 5.5. Figure 19.5 shows what may be regarded as the main finding of the study; the distribution of 42 chain lengths from our Nebraska study, in which 160 persons started in an attempt to reach a stock broker who resided in Sharon, Massachusetts. The median number of intermediate persons is 5.5, which is, in certain ways, impressive, considering the distances traversed. Recently, I asked a person of intelligence how many steps he thought it would take, and he said it would require 100 intermediate persons, or more, to move from Nebraska to Sharon. Many people make somewhat similar approximations, and are surprised to learn that only 5.5 intermediaries will—on the average—suffice. Somehow it does not accord with intuition. Later, I shall try to explain the basis of the discrepancy between intuition and fact.

It is reasonable to assume that the theoretically pure number of links needed to complete the chains is even less than that shown by our findings. First, since our participants can only send the folder on to one of their 500 possible contacts, it is unlikely that even through careful selection they will necessarily, and at all times, select a contact best able to

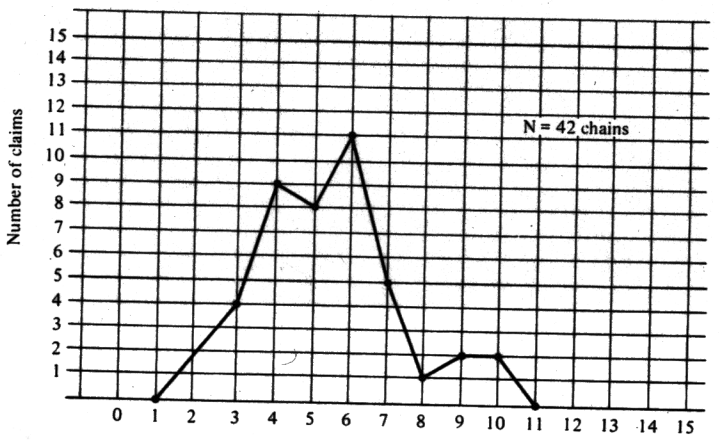



FIGURE 19.5
Number of intermediaries needed to reach target person. Each chain started in Nebraska and reached a target person in Massachusetts.



advance the chain to the target. On the whole they probably make pretty good guesses, but surely, from time to time, they overlook certain possibilities for shortcuts. The chains obtained in our empirical study are less efficient than those generated theoretically.

Secondly, the only basis for moving the folder to the target person is to work along certain highly rational lines. That is, a certain amount of information about the target person concerning his place of employment, place of residence, schooling, etc., is given to the starting subject, and it is on the basis of this information alone that he selects the next recipient of the folder. Yet, in real life, we sometimes know a person because we chance to meet him on an ocean liner, or we spend a summer in camp together as teenagers, yet these haphazard bases of acquaintanceship cannot be fully exploited by the participants.

There is one factor that could, conceivably, work in the opposite direction, that is, give us the illusion that the chains are shorter than they really are. There is a certain decay in the number of active chains over each remove even when they do not drop out because of reaching the target person. Of 160 chains that started in Nebraska, 42 were completed and 128 dropped out. These chains die before completion because a certain proportion of participants simply do not cooperate and fail to send on the folder on each remove. Thus, the results we obtained on the distribution of chain lengths occurred within the general drift of a decay curve. It is possible that some of the uncompleted chains would have been longer than those that did get completed. To account for this possibility, Professor Harrison White of Harvard has constructed a mathematical model to show what the distribution of chain lengths would look like if all chains went through to completion. In terms of this model there is a transformation of the data, yielding longer chains.

## EXAMINING THE CHAINS

There are several features of the chain worth examining, for they tell us something about the pattern of contact in American society. Consider, for example, the very pronounced tendency in our Kansas study for female participants to send the folder on to females, while males tended to send the folder on to other males. For a total of 145 subjects involved in the study, we find:

| | | | |
|---|---|---|---|
| Female | → | Female | 56 |
| Male | → | Male | 58 |
| Female | → | Male | 18 |
| Male | → | Female | 13 |

that is, subjects were three times as likely to send the folder on to someone

of the same sex as someone of the opposite sex. This is true when the target person is female, less true when the target person is a male. Exactly why this is so is not easy to determine, but it suggests that certain kinds of communication are conditioned strongly by sex roles.

Subjects also indicated on the tracer cards whether they were sending the folder on to friends, relatives, or acquaintances. In this same series, 123 cards were sent to friends and acquaintances, while only 22 were sent to relatives. Cross-cultural comparison would seem useful here. It is quite likely that in societies which possess extended kinship systems, relatives will be more heavily represented in the communication network than is true in the United States. In American society, where extended kinship links are not maintained, acquaintance and friendship links provide the preponderant basis for reaching the target person. I would guess, further, within certain ethnic groups in the United States, a higher proportion of familial links would be found in the data. Probably, if the study were limited to persons of Italian extraction, one would get a higher proportion of relatives in the chain. This illustrates, I hope, how the small world technique may usefully illuminate varied aspects of social structure, as well as cultural topics.

In Fig. 19.6 we show what kind of people were involved in some typical chains that stretched from Nebraska to Massachusetts.

Each of us is embedded in a potential small world structure. It is not enough to say, however, that each acquaintance constitutes an equally important basis of contact with the larger social world. For it is obvious that some acquaintances are more important in establishing contacts with broader social realms: some friends are relatively isolated; others possess a wide circle of acquaintances, and contact with them brings the individual into a far-ranging network of additional persons.

Let us consider in detail the pattern of convergence crystallizing around the target person of our second target person, a stock broker living in Sharon, Massachusetts, and working in Boston. A total of 62 chains reached him,[1] 24 of these at his place of residence in a small town outside of Boston. Within Sharon, fully sixteen were given to the target person by Mr. Jacobs, a clothing merchant in town. He served as the principal point of mediation between the target person and the larger world, a fact that came as a considerable surprise, and even something of a shock for the target person. At his place of work in a Boston brokerage house, ten of the chains passed through Mr. Jones, and five through Mr. Brown, business colleagues of the target person. Indeed, 48 percent of the chains to reach the target person were moved on to him by three persons: Jacobs, Jones, and Brown. Between Jacobs and Jones there is an interesting division of labor. Jacobs mediates the chains advancing to the target person by virtue of his residence. Jones performs a similar function in the occupational domain, and moves 10 chains enmeshed in the investment-brokerage network to the target person (Fig. 19.7).



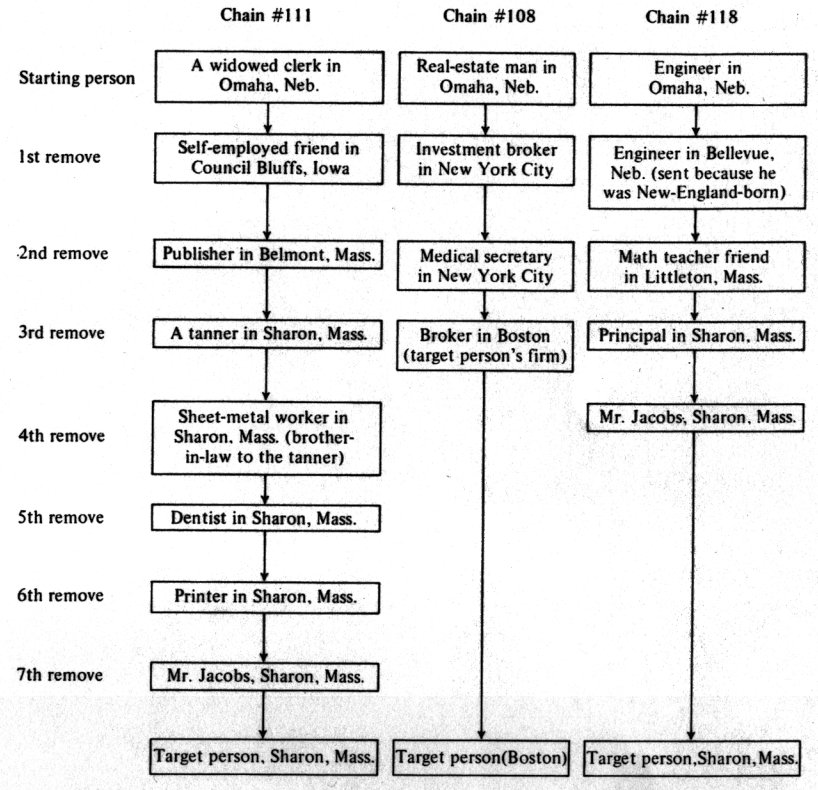



FIGURE 19.6
Typical chains in the Nebraska study.

More detail thus comes to fill out the picture of the small world. First, we learn that the target is not surrounded by acquaintance points each equally likely to feed into an outside contact; rather, there appear to be highly popular channels for the transmission of the chain. Second, there is differentiation among these commonly used channels, so that certain of them provide the chief points of transmission in regard to residential contact, while others have specialized contact possibilities in the occupational domain. For each possible realm of activity in which the target is active, there is likely to emerge a sociometric star with specialized contact possibilities.

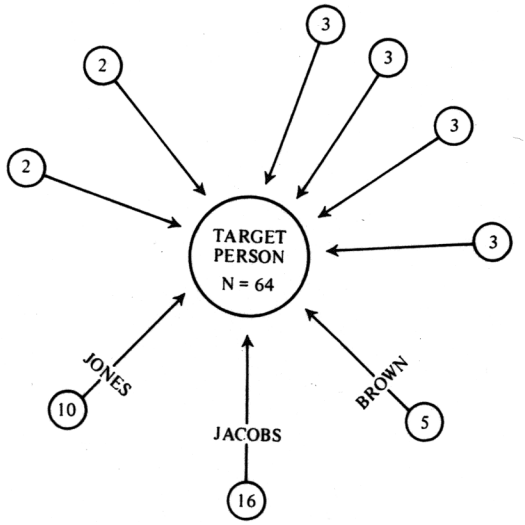



FIGURE 19.7
Convergence through common channels (includes 42 chains that started in Nebraska and 22 that started in the Boston area).

## GEOGRAPHIC MOVEMENT

Geographic movement from the state of Nebraska to Massachusetts is striking over the several links. Figure 19.8 shows the progressive closing in on the target area with each new person added to the chain. There are some cases, however, in which a chain moves all the way from Nebraska to the very neighborhood in which the target person resides, but never quite makes the necessary contact to complete the chain. Some chains have died only a few hundred feet from the target person's house, after a successful transmission of 1000 miles. Social communication is sometimes restricted less by physical distance than by social distance.

The major research focus for future inquiry calls for changing the relationship between the starting person and the target person. If the two are drawn from different class backgrounds, does this decrease the probability of completing the chain? Does it increase the number of links?

In collaboration with Charles Korte, I am now applying the small world method to the study of communications in subgroups in American society; namely, Negro and white persons. We will have Negro starting



| | |
|---|---|
| 1305 miles | (starting position) |
| 710 miles | first remove |
| 356 miles | second remove |
| 210 miles | third remove |
| 79 miles | fourth remove |
| 44 miles | fifth remove |
| 20 miles | sixth remove |
| Target area | seventh remove |

FIGURE 19.8
Geographic movement from Nebraska to Massachusetts. The chains progress toward the target area with each remove. The figure shows the number of miles from the target area with each remove averaged over all chains, completed as well as incompleted. For example, by the sixth remove, the average chain (assuming it is still active) is 20 miles from the target area. The target area is defined as any location less than 20 miles from Boston.

persons and target persons, and white starting persons, and try to trace the lines of communication between them. We would first like to ask: In what degree are the racial lines surmounted? Can any sizable fraction of the communications get through the racial barrier? If the answer is affirmative, what is the typical locus of transition? Does it occur at the neighborhood level? At the place of work? We are particularly interested in the persons who serve as links between Negro and white groups. In what way do they differ from others in the chain? Do they tend to occupy particular professional categories, such as minister, teacher, etc.? Is there any easier flow between Negroes and whites in Northern or Southern locales? Perhaps some new light can be cast on the structural relationships, between Negro and white communities by probing with the small world method.

As stated previously, many people were surprised to learn that only 5.5 intermediaries will, on the average, suffice to link randomly chosen individuals, no matter where each lives in the United States. We ought to try to explain the discrepancy between intuition and fact.

The first point to remember is that although we deal directly with only 5.5 intermediaries, behind each of them stands a much larger group of from 500 to 2500 persons. That is, each participant selects from an acquaintance pool of 500 to 2500 persons the individual he thinks is in the best position to advance the chain, and we deal only with the end product of a radical screening procedure. Second, there is an element of geometric progression implicit in the search procedure, and there is nothing more alien to mathematically untutored intuition than this form of thinking. As youngsters, any of us were asked the question: If you earned a penny a day and the sum were doubled each day, how much would you have earned by the end of a 30-day working period. Most frequently people give answers on the order of $1.87 or $6.45, when in fact the sum is more

than $10,000,000 for one 30-day working period, the last day alone yielding $5,368.709.12 in wages. Elements of geometric progression with an increase rate far more powerful than mere doubling underlies the small world search procedure, and thus, with only a few removes, the search extends to an enormous number of persons.

Finally, when we state there are only 5.5 intermediate acquaintances, this connotes a closeness between the position of the starting person and the target persons, but this is in large measure misleading, a confusion of two entirely different frames of reference. If two persons are 5.5 removes apart, they are far apart indeed. Almost anyone in the United States is but a few removes from the President, or from Nelson Rockefeller, but this is only as seen from a particular mathematical slant and does not, in any practical sense, integrate our lives with that of Nelson Rockefeller. Thus, when we speak of five intermediaries we are talking about an enormous psychological distance between the starting and target points, a distance which only seems small because we customarily regard "5" as a small, manageable quantity. We should think of the two points as being not five persons apart, but five "circles of acquaintances" apart—five "structures" apart. This helps to set it in its proper perspective.

There is an interesting theorem based on the model of the small world. It states that if persons from two different populations cannot make contact, that no one within the entire population in which each is embedded can make contact with any person in the other population. Said differently, given person *a* embedded in population *A* (which consists of his circle of acquaintances), and person *b* embedded in population *B*, if *a* cannot make contact with *b*, then:

1. No other individual in *A* can make contact with *b*.
2. No other individual in *A* can make contact with any other individual in *B*.
3. In other words, the two subpopulations are completely isolated from each other.

Conceivably, this could happen if one of the populations were on an island never visited by the outside world. In principle, any person in the United States can be contacted by any other in relatively few steps, unless one of them is a complete and total hermit and then he could not be contacted at all.

In sum, perhaps the most important accomplishment of the research described here is that—although people have talked about small world connections, and have even theorized about it—these are, to my knowledge, the first empirically created connections between persons chosen at random from a major national population.

Although the study started with a specific set of questions arising from the small world problem, the procedure illuminates a far wider set of topics. It reveals a potential communication structure whose characteristics have yet to be exposed. When we understand the structure of this potential communication net, we shall understand a good deal more about the integration of society in general. While many studies in social science show how the individual is alienated and cut off from the rest of society, from the perspective of this study a different view emerges: in some sense, at least, we are all bound together in a tightly knit social fabric.



## NOTE

1. This includes the 42 originating in Nebraska and 20 additional chains originating in the Boston area.

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